

CLAIMS

I claim:

1. A method of modeling seismic data, comprising:
 - deriving a time-lapse data set from a first seismic data set and a second seismic data set;
 - deriving a forward-modeled time-lapse data set including a plurality of values;
 - sorting the plurality of values into a plurality of bins corresponding to the forward-modeled time-lapse data set;
 - selecting a plurality of optimal values from the plurality of bins;
 - mapping the plurality of optimal values in correspondence with a plurality of subterranean locations using the time-lapse data set;
 - calibrating the plurality of optimal values; and
 - plotting the plurality of calibrated optimal values.
2. The method of claim 1, and wherein the deriving the forward-modeled time-lapse data set is defined by deriving the forward-modeled time-lapse data set using at least one rock physics relationship.
3. The method of claim 1, and further comprising acquiring the first seismic data set and thereafter acquiring the second seismic data set.
4. The method of claim 1, and wherein the first seismic data set and the second seismic data set both include amplitude-versus-offset signal data.
5. The method of claim 1, and wherein the first seismic data set and the second seismic data set both include amplitude-versus-angle signal data.
6. The method of claim 1, and wherein the first seismic data set and the second seismic data set both include data corresponding to reflected acoustic wave energy.
7. The method of claim 1, and wherein the deriving the forward-modeled time-lapse data set is defined by deriving the forward-modeled time-lapse data set using respectively selected pore pressure and saturation and porosity relationships.

1 8. The method of claim 1, and wherein the deriving the time-lapse data set is
2 defined by calibrating each of the first seismic data set and the second seismic data set
3 and thereafter subtracting the calibrated second seismic data set from the calibrated first
4 seismic data set.

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6 9. The method of claim 1, and wherein the deriving the time-lapse data set is
7 defined by inverting and then calibrating each of the first seismic data set and the
8 second seismic data set and thereafter subtracting the calibrated inverted second
9 seismic data set from the calibrated inverted first seismic data set.

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11 10. The method of claim 1, and wherein the plotting the calibrated values is
12 defined by plotting the calibrated values to visually represent a spatial distribution of at
13 least one physical characteristic of a subterranean hydrocarbon reservoir.

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15 11. The method of claim 1, and wherein the selecting the plurality of optimal
16 values sorted into the plurality of bins is performed in response to comparing the plurality
17 of values with at least one comparison value, and wherein the at least one comparison
18 value optionally includes a reservoir measurement value.

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20 12. The method of claim 1, and wherein the calibrating the plurality of optimal
21 values is performed in response to comparing the plurality of optimal values with at least
22 one comparison value, and wherein the at least one comparison value optionally
23 includes a reservoir measurement value.

1 13. A method of modeling seismic data corresponding to a subterranean
2 reservoir containing hydrocarbons, comprising:
3 calibrating each of a first seismic data set and a second seismic data set;
4 subtracting the calibrated second seismic data set from the calibrated first
5 seismic data set to derive a time-lapse data set;
6 deriving a forward-modeled time-lapse data set including a plurality of physical
7 parametric values;
8 sorting the plurality of physical parametric values into a plurality of bins
9 corresponding to the forward-modeled time-lapse data set;
10 selecting a plurality of optimal physical parametric values from the plurality of bins
11 of physical parametric values;
12 mapping the plurality of optimal physical parametric values to a corresponding
13 plurality of subterranean locations using the time-lapse data set;
14 calibrating the plurality of optimal physical parametric values; and
15 plotting the plurality of calibrated optimal physical parametric values as a visual
16 representation of the subterranean reservoir containing hydrocarbons.

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18 14. The method of claim 13, and wherein:
19 the calibrating each of the first seismic data set and the second seismic data set
20 is performed in response to comparing each of the first seismic data set and the second
21 seismic data set with at least one comparison value; and
22 the at least one comparison value optionally includes a reservoir measurement
23 value.

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25 15. The method of claim 13, and wherein the first seismic data set and the
26 second seismic data are respectively defined by an inverted first seismic data set and an
27 inverted second seismic data set.

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29 16. The method of claim 13, and wherein the deriving the forward-modeled
30 time-lapse data set is defined by deriving the forward-modeled time-lapse data set using
31 a rock physics relationship.

1 17. The method of claim 16, and wherein the rock physics relationship
2 corresponds to a selected one of a pressure relationship, a saturation relationship, or a
3 porosity relationship.
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5 18. The method of claim 13, and wherein the selecting the plurality of optimal
6 physical parametric values sorted into the plurality of bins is performed in response to
7 comparing the plurality of physical parametric values with at least one comparison value,
8 and wherein the at least one comparison value optionally includes a reservoir
9 measurement value.
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11 19. The method of claim 13, and wherein the calibrating the plurality of optimal
12 physical parametric values is performed in response to comparing the plurality of optimal
13 physical parametric values with at least one comparison value, and wherein the at least
14 one comparison value optionally includes a reservoir measurement value.
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16 20. The method of claim 13, and wherein the first seismic data set and the
17 second seismic data set both include amplitude-versus-offset signal data.
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19 21. The method of claim 13, and wherein the first seismic data set and the
20 second seismic data set both include amplitude-versus-angle signal data.
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22 22. The method of claim 13, and wherein the first seismic data set and the
23 second seismic data set both include data corresponding to reflected acoustic wave
24 energy.

1 23. A computer, comprising:
2 a processor;
3 a computer-readable storage medium coupled in data communication with the
4 processor, the computer-readable storage medium storing a first data set and a second
5 data set and a plurality of rock physics relationships and a program code, the program
6 code configured to cause the processor to:
7 calibrate each of the first data set and the second data set;
8 subtract the calibrated second data set from the calibrated first data set to
9 derive a time-lapse data set;
10 calculate a forward-modeled time-lapse data set including a plurality of
11 parametric values using selected ones of the plurality of rock physics
12 relationships;
13 sort the plurality of parametric values into a plurality of bins corresponding
14 to the forward-modeled time-lapse data set;
15 select a plurality of optimal parametric values from the plurality of
16 parametric values sorted into the plurality of bins;
17 map the plurality of optimal parametric values to a corresponding plurality
18 of subterranean locations using the time-lapse data set;
19 calibrate the plurality of optimal parametric values; and
20 plot the plurality of calibrated optimal parametric values to visually
21 represent at least one spatially distributed physical characteristic of a
22 subterranean reservoir of hydrocarbons.

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24 24. The computer of claim 23, and wherein the first data set and the second
25 data set stored in the computer-readable storage medium both include one of amplitude-
26 versus-offset data, or amplitude-versus-angle data.

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28 25. The computer of claim 23, and wherein the first data set and the second
29 data set both include data corresponding to reflected acoustic wave energy.

1 26. The computer of claim 23, and wherein the program code stored within the
2 computer-readable storage medium is further configured to cause the processor to:
3 compare each of the first data set and the second data set with at least one
4 comparison value; and
5 calibrate each of the first data set and the second data set in response to the
6 comparing.

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8 27. The computer of claim 23, and wherein the first data set and the second
9 data set are respectively defined by an inverted first data set and an inverted second
10 data set.

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12 28. The computer of claim 23, and wherein the plurality of rock physics
13 relationships stored in the computer-readable storage medium are defined by at least
14 one of pressure relationships, saturation relationships, or porosity relationships.

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16 29. The computer of claim 23, and wherein the program code stored in the
17 computer-readable storage medium is further configured to cause the processor to
18 compare the plurality of parametric values sorted into the plurality of bins with at least
19 one comparison value, and to select the plurality of optimal parametric values in
20 response to the comparing.

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22 30. The computer of claim 29, and wherein the at least one comparison value
23 includes a measurement value corresponding to the subterranean reservoir containing
24 hydrocarbons.

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26 31. The computer of claim 23, and wherein the program code stored in the
27 computer-readable storage medium is further configured to cause the processor to
28 compare the plurality of optimal parametric values with at least one comparison value,
29 and to calibrate the plurality of optimal parametric values in response to the comparing.

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31 32. The computer of claim 31, and wherein the at least one comparison value
32 includes a measurement value corresponding to the subterranean reservoir containing
33 hydrocarbons.

1 33. The computer of claim 23, and wherein the program code stored in the
2 computer-readable storage medium is further configured to cause the processor to plot
3 the plurality of optimal parametric values selectively using one of a monitor or a printer
4 coupled to the computer.
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6 34. The computer of claim 23, and wherein the at least one spatially
7 distributed physical characteristic of the subterranean reservoir containing hydrocarbons
8 is defined by at least one of a porosity, a pressure, or a saturation.